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TR-76-31-FEL

PILOT PLANT PRODUCTION OF FROZEN ENTREE ITEMS FOR THE NAVY

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September 1976

UNITED STATES ARMY
NATICK RESEARCH and DEVELOPMENT COMMAND
NATICK, MASSACHUSETTS 01760

FOOD ENGINEERING LABORATORY
FEL-59

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Six frozen meat entrees: Oven Fried Chicken, Swiss Steak with Brown Gravy, Lasagna, Sweet and Sour Pork, Creole Pork Slices, and Turkey a la King were prepared for a Navy submarine feeding test. Two hundred and forty pounds of Oven Fried Chicken and 200 pounds of each of the other five products were furnished to the Navy for the test. Additional portions of each product were placed into storage for stability determination, provided for nutritional studies, and used to determine preparation instructions for the Navy.

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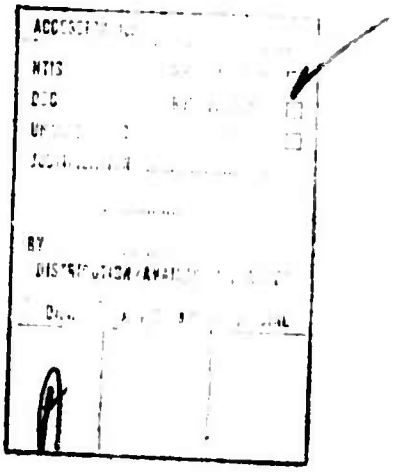
20. Abstract (Con't)

Initial data shows the products were well accepted by a technological panel and were microbiologically safe. Results of the in-house storage stability study, nutritional study, and the Navy evaluation will be presented in a separate report.



PREFACE

The US Army Natick Research and Development Command (NARADC(M), formerly Natick Development Center (NDC), has R&D responsibility for all food consumed by the four Armed Services. In a meeting between NARADCOM and Navy personnel held at this Command in January 1975 to discuss feeding problems aboard submarines, it was recognized that there is an in-port problem with conventional food preparation. Generally, when in port one of the two cooks in the crew is allowed leave or is sent for special training, thus leaving only one cook to prepare meals for up to 40 people at breakfast, 80 at lunch, and 40 at dinner. Thus, it would be very advantageous if convenience foods could be used.

It was pointed out that NARADCOM has been working on frozen foods for the Army (Central Food Preparation Facilities) and the Air Force (F.E. Warren Air Force Base). Due to the need for refinement of production methods and for nutritional data under conditions of use, NARADCOM planned to prepare large batches of several products. Since there would be no use for most of finished product at Natick, it was suggested that the Navy use the remainder for evaluation at Norfolk. This would give the Navy an opportunity to determine the feasibility of using this type of convenience food in in-port submarines, while providing NARADCOM with acceptance and usage data obtained in an operating situation.

The protocol furnished the Navy for determining operational efficiency and consumer acceptance will be detailed in a second report which will also include in-house technological evaluation and nutritional analysis.

The Armed Forces Recipe Service publishes recipes used by the four services. These are based upon 100-portion size batches and are intended for preparation in a kitchen. In general, in developing a particular frozen entree, the recipe for that item is adjusted to permit freezing the product and to fit it to a large-scale production. These revised recipes are called "production guides", and, as they are developed for a particular use, they are published as technical reports. It is recognized, first, that these guides will have to be altered to fit the layout, equipment, and general circumstances of any given production site; and, second, that the guides themselves, in many cases, can be simplified to facilitate production without downgrading quality. In addition, more acceptance and nutritional information is needed about frozen entrees used in a military environment.

This study was undertaken under Project No. 1T762724A043 Military Food Service and Subsistence Technology.

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The authors also appreciate the efforts of Messrs. V. De Milia and W. Gustafson in the packing and delivery of the food products to the Navy test site.

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INTRODUCTION

The trend in feeding the Armed Services in garrison situations has been moving toward convenience foods. In this it parallels the trend in commercial and institutional feeding, although it lags somewhat due to current costing procedures as well as the number of items in the menu which are problems somewhat peculiar to the Armed Services. Frozen entree products are being used in increasing volume for mass feeding as one of several types of convenience foods. Because of the actual or potential use of frozen entree items in military feeding, NARADCOM has expended considerable effort in this area.

It was decided that in order to meet the needs of both NARADCOM and the Navy, six entree and six vegetable products would be prepared by NARADCOM and supplied to the Navy. NARADCOM would furnish the Navy the product with preparation instructions, and in addition, would conduct technological taste panels and set up nutritional studies.

This report is concerned only with the six entree items: Oven-Fried Chicken, Swiss Steak with Brown Gravy, Lasagna, Sweet and Sour Pork, Creole Pork Slices, and Turkey a la King.

MATERIALS AND METHODS

The entrees were made in accordance with the production guides contained in the report by Helmer and Schlup (1975)[1]. For convenience, the production parts of these guides are reproduced herein and are contained in Tables 1 to 6.

Steaks for the swiss steak with brown gravy were obtained from boneless beef top rounds. The rounds were cut into square roasts of the approximate size of the steak, shell frozen, then sliced into 12.7 cm thick slices. Trim from the rounds was used for baked lasagna.

Fresh, whole, grade A turkeys were procured for turkey a la king. The breast and thigh meat was removed from the carcasses, formed into rolls (60:40; light:dark), cooked, then diced into approximately 2.5-cm cubes.

Chicken was obtained as fresh, whole, broilers-fryers (1.0 to 1.4 kg) from a local slaughter house. The birds were cut into eight portions: two each of wings, drum sticks, thighs, and breast pieces. Backs, necks, and giblets were not used.

Pork for creole pork slices and sweet and sour pork was taken from whole, bone-in pork loins (5.8 to 8.8 kg each). The loins were obtained from midwestern raised hogs. The end roasts, tenderloins, and other lean trim was diced and used for the sweet and sour pork (approximately 2.5-cm dices). The longissimus dorsi muscle was stuffed into size 2-1/2 casings for shaping, frozen (-29°C) tempered to -2.2°C and sliced into 12.7-cm-thick slices using a Bettcher model 39 power cleaver.

The remaining ingredients were obtained from local wholesale grocery and produce suppliers.

The products were packaged in 26 cm x 20 cm x 6.5 cm rigid foil half-size steam table pans. The aluminum lids were mechanically crimped onto the pan to insure a sealed package. The products were frozen in a blast freezer at -29°C.

As part of the project, as much information as possible was obtained on production parameters such as yields and in areas where problems occurred. The causes were determined as far as possible. The problems are being investigated at the present time.

[1] Helmer, R.L. and H.T. Schlup, 1975. Meat Entree Item Production Guides Developed for use in Ft. Lee Interim Central Food Preparation Facility. USANDC Technical Report TR-74-27-FEL

RESULTS AND DISCUSSION

Product Preparation

Two specific problems were encountered which were of sufficient magnitude to be investigated separately. There was a greenish tinge to the finished turkey a la king and a breakdown in the frying oil used in preparation of pork in creole pork slices.

The greenish tinge to the turkey a la king was traced to the soup and gravy base used in the formula. It was further traced to the wrong color tumeric being used in the base. The product came from a procurement based upon the military specification which does specify the yellow tumeric rather than the green. Taste panel (consumer) results (Table 7) indicated that the off-color turkey a la king while in an acceptable range, rated significantly lower in color acceptability. Therefore, the product was remade using the correct soup and gravy base with the off-color product being reserved for temperature studies, etc.

Deterioration of fat used in deep fat frying is both a substantial product cost factor and product quality factor. Certain trace metals can act as pro-oxidants in frying oil and can cause rapid deterioration. Williams (1966)[2] states that as little as one part of copper or 10 parts of iron per 100 million parts of oil can have a deleterious effect. Thus, when the oil broke down very rapidly in frying the pork slices, trace metals were suspected. Analysis of the dredging mix (Table 8) did show extensive trace metals, and frying pork in fresh oil without the dredging mix applied to the pork resulted in no breakdown. Table 8 shows that the spices, pepper, paprika, and thyme, used in the dredging mix were a primary source of the trace metals, copper and iron. The flour and salt also contributed substantial amounts of iron. The production time schedule did not permit investigation of the problem at the time of manufacture of the product. A factorial experiment has been designed to fully elucidate the factors involved and the corrective measures necessary to prevent recurrence of the problem. Effect of the oil breakdown on the product was the imparting of a smoky flavor. It was readily noticeable, but the majority of consumer taste panelists did not object to it. However, the flavor was getting progressively stronger as the breakdown continued, and it would have become very bitter if use of the oil and dredging material had continued.

[2] Williams, K.A., 1966. Oils, Fats and Fatty Foods, 4th Ed. NY American Elsevier Publishing Company, Inc. 488 pp.

Yields

Yields were determined for the various meat components with the results being shown in Tables 9-12. With the exception of bones and similar material, the category of product labeled "waste" would be used somewhere in a large, integrated operation. The yield results should be taken as approximations only, to be used for preliminary calculations and for use in raw material acquisition when similar pilot studies are planned.

Weights were determined of swiss steaks and pork slices before addition of gravy or sauce and of chicken pieces and lasagna in each pan produced. With the exceptions of lasagna, meat in the pans was determined by piece count. Swiss steak weighed an average of 1.1 kg per pan with a range of 0.5 kg to 1.4 kg with 12 steaks per pan. Fifty pans (54 percent) weighed below 1.1 kg.

Oven-fried chicken weighed an average of 1.9 kg per pan with a range of 1.6 kg to 2.4 kg per pan (16 pieces per pan: 4 breast pieces, 4 drumsticks, 4 thighs, 4 wings). Nine pans (8 percent) weighed 2.3 kg or more while 38 pans (35 percent) weighed 1.8 kg or less. Even with as little as 1.8 kg per pan, the pan lid bulged. Sixty pans of chicken were sent to the Navy to assure that they received the 109 kg needed for their test.

The average weight of pork slices was 1.2 kg per pan. The range of weights per pan were 1.1 kg to 1.4 kg. Twenty-four pork slices were placed into each pan.

Lasagna had an average weight of 2.3 kg per pan with a range of 2.0 kg to 2.6 kg per pan.

Samples from each lot were sent to the Microbiology Branch, Food Sciences Laboratory. The results of the microbiological analysis are shown in Table 13.

Heating Curves

Heating curves were made for each entree. Each product was heated from both the frozen state and after tempering in a 5°C refrigerator for 18 to 24 hours. The tempered product was heated in an oven set at 192°C and the frozen product was heated in an oven set at 262°C. A conventional oven was used because this is the type the Navy has on board the submarines involved in the test. The heating curves developed from the data are shown in Figures 1 through 6. Preliminary attempts to heat product from the frozen state in an oven set at 192°C resulted in an excessively long period of heating (Figure 1, closed triangle, point up). Very little scorched product was observed resulting from either method of heating. As expected, some adherence of the product to the side of the pan occurred.

The data obtained from the heating was used to prepare instructions for heating of the product for serving. The labels used are shown in Figure 7. One label showing the name of the product and one containing the directions for use were affixed to each pan of product.

Examination of the heating curves shows that the results are slightly erratic. At each oven setting (192° and 262°C) each product produced curves that in one instance show rapid heating but in another instance show slow heating. Some of the probable responsible factors for the variance in the heating characteristics within pans of the same product are:

(1) Temperature of the product at the start of the heating test. Serious effort was made to start heating the product from the same temperature each time. However, the heating curves show that this did not always happen.

(2) The influence of different products in the same oven load on the heating characteristics of all the other products. The exigency of the project did not allow time to develop heating curves by heating only one product in an oven load.

(3) The effect of oven load on heating curves. The ovens used by the Navy aboard the submarines involved in this test have a capacity of three half-size steam table pans. In developing the heating curves it was sometimes necessary to use a pan of starch solution to fill up the space normally occupied by a pan of product to keep the oven load as near to the Navy conditions as possible. In later trials this was not always done. To determine the effect of oven load on the heating curve(s) obtained, an experiment was conducted with turkey a la king. Figure 8A shows the heating curve for one pan, Figure 8B for two pans, Figure 8C for three pans, and Figure 8D for four pans. In general, oven load seems to have some influence on the heating curve obtained.

(4) The position of the thermocouple in the product. Every effort was made to place thermocouples in the coldest spot in the various panned products. It is possible that thermocouples could have been displaced when the pans of product were handled during processing.

(5) The ratio of solids to liquid. Products such as turkey a la king and sweet and sour pork required constant agitation during panning to keep the meat pieces evenly suspended in the sauce. Even with good agitation, some differences were noted in pans of the product used for organoleptic evaluation. The differences were not determined quantitatively.

Swiss steak, oven fried chicken, and creole pork slices were panned by the number of pieces of meat. In the case of swiss steak and creole pork slices, sauce or gravy was used to make up the difference between the weight of meat in the pan and the 2.3 kg per pan required. The average weight of meat per pan and the range of weights were: swiss steak, average 1096.6 g, range 878.8 g to 1,417.5 g; oven fried chicken, average 2,141.2 g range 1,587.6 g to 2,381.4 g; creole pork slices, average 1,228.5 g, range 765.4 g to

1,360.8 g. Lasagna, layered into each pan, had an average weight of 2305.1 g with a range of 2041.2 g to 2,551.5 g. It can be concluded from the foregoing discussion that a number of factors can influence the shape of a heating curve of a product. More extensive investigation is required to elucidate the precise amount of influence each factor has on the shape of the heating curve. Other factors not yet recognized may also play a role in how a product heats. However, it must be recognized that there are wide variations among ovens and, in fact, often hot and cold spots in a given oven.

Production Evaluation

The initial acceptability of the frozen entrees for the Navy was based on technological panel evaluation of color, odor, flavor, texture, and appearance rated on a 9-point scale (1 = extremely poor; 9 = excellent). Two samples of each product were selected at random for presentation to the panel of food technologists at Natick who were familiar with the six frozen entrees. Preparation of the samples for serving was accomplished following the individual reconstitution directions listed for each product in directions shown in Figure 7. Once the products were heated to 71.1°C, they were held at 60°C during serving. Only one product at a time with its duplicate was served at a session, except for creole pork slices where three samples were evaluated in one session and two samples in a separate test.

Once the products had passed the technological screening, they were evaluated by a 36-member consumer panel at NARADCOM on a 9-point scale for acceptability. The consumer tests were conducted by the Food Acceptance Group of the Food Sciences Laboratory, at NARADCOM. The population from which the consumer panel was drawn is comprised of volunteers from all of the Command's employees including tenant activities.

CONCLUSIONS

Results of technological sensory evaluation are recorded in Table 14. Turkey a la King, Oven-Fried Chicken, Sweet and Sour Pork, Swiss Steak with Brown Gravy, and Lasagna were found to be acceptable. Two samples of each item were served, designated A and B. There are some differences in a few instances between the A and B products. They can be attributed primarily to uneven distribution. The three additional tests of Creole Pork Slices were conducted because of the oil failure. Results indicate that the presence of the smoky flavor was accepted by the panel.

Results of the consumer panel reported in Table 12 indicate the generally high quality of the reconstituted precooked frozen entrees. Having passed the consumer panel, all items were scheduled for shipment to the Navy.

TABLE 1. Production Guide Used for Swiss Steak With Brown Gravy

Ingredients	Percent of Recipe	Recipe Weight for 100 portions (Grams)	Weight Required for 90 pans (Grams)	Procedure No.
Beef, boneless, swiss steak	44.77	16,344	146,966	1
Flour, pastry	2.74	999	8,981	
Pepper, black	0.02	8	82	
Salt	0.22	82	735	
Shortening, vegetable	4.48	1,632	12,247	2,3,4
Water, hot	19.90	7,264	58,623	5
Onions, dehydrated, sliced	0.53	195	1,755	
Garlic powder	0.01	4	41	6
Pepper, black	0.02	6	82	
Salt	0.24	86	776	
Soup and gravy base, beef	0.27	100	898	
Starch, (Col Flo 67)	0.34	123	1,102	
Beef stock or water	26.12	9,534	85,730	7,8
Worcestershire sauce	0.34	123	1,102	
Totals	100.00	36,500	319,120	

TABLE 1 Con't

Procedure:

1. Dredge steaks in seasoned flour. Shake off excess.

2. Brown steaks on well greased griddle.

3. Shingle 50 steaks in a field pan, add 3.6 kg of hot water to each pan, cover and heat in a 162.8°C oven for 2 hours. Saving of stock is optional.

4. Place 10 to 12 steaks in each of 90 half-size aluminum steam table pans. Set aside for step 7.

5. Rehydrate onions in excess water, hold 10 minutes, drain thoroughly and heat in a greased pan until brown and tender. Save for step 6.

6. Combine all seasonings, starch, onions, worcestershire sauce, and stock or water together in a steam kettle and heat to a boil. Simmer gravy for 10 minutes. Bring volume back to proper level for batch size by adding water.

7. Add 2 pounds of gravy to each pan of meat.

8. Cover, label, and freeze.

Preparation for serving:

Heat in a convection oven heated to 162.8°C, to an internal temperature of 73.9°C (approximately 1 to 1.5 hours). Keep pans covered during heating.

TABLE 2. Production Guide Used for Turkey a la King

Ingredients	Percent of Recipe	Recipe Weight for 100 portions (Grams)	Weight Required for 90 pans (Grams)	Procedure No.
Shortening, all purpose	3.74	1,134	10,206	1
Flour, pastry	1.87	567	5,103	
Starch, Col Flo 67	1.87	567	5,103	2
Water, warm	37.70	11,431	102,877	
Soup and gravy base, chicken	1.12	340	3,062	
Salt	0.28	85	762	3
Pepper, black	0.04	14	127	
Onions, dehydrated, chopped	0.19	57	508	
Celery, fresh, chopped	7.48	2,286	20,412	
Turkey, boneless, cooked, 1-inch-dice size	29.92	9,072	81,648	4
Peppers, sweet, fresh chopped	1.49	454	4,082	
Pimientos, canned, chopped	1.31	397	3,574	
Milk, nonfat, dry	1.22	369	3,320	5,6,7,8
Water, warm	11.77	3,569	32,151	
Totals	100.00	30,342	272,935	

TABLE 2 Con't

Procedure:

1. Place shortening in steam kettle and heat. Stir in flour to make a roux. Cook 40 minutes.

2. Mix Col Flo 67, soup and gravy base, and water together and add to roux. Heat until thickened.

3. Add seasonings and vegetables, bring to a boil, stirring constantly.

4. Add diced turkey, peppers, and pimientos to mixture and heat.

5. Reconstitute milk and add to ingredients.

6. Adjust volume, by adding water, to proper level for batch size. Heat to simmering temperature. Do not boil.

7. Scale 2.3 kg of product into each of 90 half-size aluminum steam table pans.

8. Cover, label, and freeze.

Preparation for Serving

Heat in a convection oven heated to 162.8° to 176.7°C to an internal temperature of 73.9°C (approximately 1 to 1.5 hours). Keep pans covered during heating.

TABLE 3. Production Guide Used For Oven Fried Chicken

Ingredients	Percent of Recipe	Recipe Weight for 100 portions (Grams)	Weight Required for 97 pans (Grams)	Procedure No.
Chicken, broiler-fryer, cut-up	74.54	18,160	138,348	1
Flour, pastry	5.59	1,362	8,301	2
Salt	0.93	227	1,383	
Pepper, black	0.02	5	27	
Milk, nonfat, dry	0.75	182	1,107	3
Water	5.13	1,249	7,611	
Egg, whole, beaten	3.73	908	5,534	
Bread crumbs	9.31	2,270	13,835	4,5,6,7,8
Totals	100.00	24,363	176,146	

Procedure:

1. Separate chicken into individual parts (wings, legs, thighs, breasts). Wash thoroughly, drain.
2. Dredge chicken in seasoned flour. Shake off excess. Set aside for Step 3.
3. Reconstitute milk with water; add eggs and mix thoroughly. Dip chicken in egg mixture. Drain and set aside for Step 4.
4. Dredge chicken in bread crumbs. Shake off excess.
5. Brown chicken in deep fat fryer at 185°C, for 45 seconds or until browned.
6. Place browned chicken in open pans and bake at 176.7°C, to an internal temperature of 73.9°C (approximately 1 hour).

TABLE 3 Con't

7. Place 16 pieces (4 wings, 4 thighs, 4 legs, and 4 breasts) in half-size-steam table pans.

8. Cover, label, and freeze.

Preparation for Serving:

Heat in a convection oven, preheated to 176.7°C, to an internal temperature of 73.9°C (approximately 1 to 1.5 hours). Keep pans covered during heating, except remove cover during last 15 to 20 minutes to crisp chicken.

TABLE 4. Production Guide Used for Baked Lasagna

Ingredients	Percent of Recipe	Recipe Weight for 100 portions (Grams)	Weight Required for 79 pans (Grams)	Procedure No.
Beef, boneless, ground	15.78	4,540	27,670	1,2
Oil or shortening	0.32	91	544	
Tomato paste, canned	14.20	4,086	24,903	3,4,5
Tomatoes, crushed, canned	18.94	5,448	33,204	
Water	15.78	4,540	27,670	
Bay leaves, finely ground	0.01	1	27	
Oregano, ground	0.06	20	109	
Pepper, cayenne, red	0.01	4	27	
Salt	0.04	114	694	
Sugar, granulated	0.04	114	694	
Pepper, black	0.01	4	27	
Onions, dehydrated, chopped	0.79	227	1,384	
Garlic powder	0.01	3	27	
Thyme, ground	0.04	12	82	
Starch, Col Flo 67	0.04	114	694	
Eggs, whole, beaten	4.34	1,248	7,611	6
Cheese, cottage	10.26	2,951	18,008	
Cheese, grated, parmesan	1.18	341	2,078	
Parsley flakes, dehydrated	0.03	8	54	

TABLE 4 Con't

Ingredients	Percent of Recipe	Recipe Weight for 100 portions (Grams)	Weight Required for 100 pans (Grams)	Procedure No.
Noodles, lasagna, whole	7.10	2,043	12,451	7,8,9
Salt	0.49	140	857	
Oil, vegetable	0.40	114	694	
Cheese mozzarella, sliced	7.10	2,043	12,451	10,11,12
Cheese, grated, parmesan	1.95	568	3,456	13
Totals	100.00	28,774	175,416	

Procedure

1. Add oil to steam kettle, spread evenly on inside to prevent meat from sticking.
2. Add ground beef and heat until meat looses its red color. Hold for step 3. Excess fat may be drained.
3. Combine all seasoning ingredients together in the steam kettle containing the cooked ground beef, mix thoroughly.
4. Heat to a boil then simmer for 30 minutes with occasional stirring.
5. Bring volume back to proper level for batch size with hot water. Reheat to 82.2°C. Hold for panning.
6. Combine all filling ingredients, mix thoroughly and set aside for panning. Hold under refrigeration if not used within 30 minutes.
7. Add sufficient water to a steam kettle (for 2,043 grams of noodles use 22.7 l of water), mix in salt, and heat to a boil.
8. Add noodles and cook with constant stirring until tender. Do not overcook.

TABLE 4 Con't

9. Rinse thoroughly with cold water, drain, add oil, mix well. Set aside for panning.

10. Set cheeses aside for panning.

11. Pan according to the following:

    a. Layer 1 - Sauce, 453.6 grams, spread evenly over bottom of a half-size steam table pan.

    b. Layer 2 - Noodles, 170.1 grams, laid evenly on sauce.

    c. Layer 3 - Filling, 170.1 grams, spread evenly over noodles.

    d. Layer 4 - Mozzarella cheese, 56.7 grams, laid evenly over filling.

    e. Layer 5 - Sauce, 453.6 grams, spread evenly over cheese.

    f. Layer 6 - Noodles, 170.1 grams, laid evenly on sauce.

    g. Layer 7 - Filling, 170.1 grams, spread evenly over noodles.

    h. Layer 8 - Mozzarella cheese, 56.7 grams, laid evenly over filling.

    i. Layer 9 - Noodles, 170.1 grams, laid evenly over cheese.

    j. Layer 10 - Sauce, 453.6 grams, spread evenly over noodles.

    k. Layer 11 - Parmesan cheese, 42.5 grams, spread evenly over sauce.

12. Heat pans of covered lasagna in a 162.8°C oven to an internal temperature of 73.9°C (approximately 30 minutes).

13. Label and freeze.

Preparation for Serving:

Heat in a convection oven heated to 162.8°C to an internal temperature of 73.9°C (approximately 1 to 1.5 hours). Keep pans covered during heating. Allow reheated product to stand, uncovered, at room temperature for 15 minutes before cutting to allow sauce to firm.

TABLE 5. Production Guide Used For Creole Pork Slices

Ingredients	Percent of Recipe	Recipe Weight for 100 portions (Grams)	Weight Required for 10l pans (Grams)	Procedure No.
Pork slices, boneless	63.12	15,875	160,167	1
Flour, all purpose	3.16	794	8,029	
Salt	0.45	113	1,134	
Pepper, black	0.02	6	45	
Paprika, ground	0.04	11	136	
Thyme, ground	0.03	9	45	
Onions, dehydrated, chopped	0.34	85	862	2
Water	0.68	170	1,678	
Peppers, sweet, fresh, sliced	2.70	680	6,849	
Celery, fresh, sliced	2.70	680	6,849	
Shortening	1.80	454	4,581	
Tomatoes, canned, crushed	23.00	5,783	58,333	3
Salt	0.23	57	544	
Pepper, black	0.02	6	45	
Sugar	0.23	57	544	
Worcestershire sauce	0.21	28	272	
Flour, all purpose	0.23	57	544	4,5,6
Starch, Col Flo 67	0.23	57	544	
Water	0.90	227	2,268	
Totals	100.00	25,149	253,469	

TABLE 5 Con't

Procedure:

1. Dredge slices in seasoned flour. Shake off excess. Deep fat fry at 176.7°C for 2 to 3 minutes until golden brown.

2. Rehydrate onions with water provided. Saute onions, peppers, and celery in shortening until tender.

3. Add tomatoes and seasonings to vegetables. Bring to a boil and simmer for 10 minutes.

4. Blend flour, starch, and water to make a smooth paste. Add to sauce. Adjust volume to proper level for batch size. Simmer sauce 5 minutes or until thickened, stirring constantly.

5. Shingle 24 Pork Slices (made from bone-in pork loins, 6.3 to 7.2 kg each) into each half-size steam table pan. Add enough sauce to each pan so that a final weight of 2.3 kg per pan is obtained.

6. Cover, label and freeze.

Preparation for Serving:

Heat in a convection oven heated to 162.8° to 176.7°C to an internal temperature of 73.9°C (approximately 1 to 1.5 hours). Keep pans covered during heating.

TABLE 6. Production Guide for Sweet and Sour Pork

Ingredients	Percent of Recipe	Recipe Weight for 100 portions (Grams)	Weight Required for 100 pans (Grams)	Procedure No.
Pork, diced, boneless	35.39	14,516	131,998	1,2
Egg, whole, beaten	1.06	435	3,946	
Soy sauce	1.06	435	3,946	
Starch, Col Flo 67	1.06	435	3,946	
Salt	0.26	107	998	
Garlic powder	0.01	4	36	
Bean sprouts, canned	14.33	5,880	53,479	3
Pineapple, canned, chunks	7.17	2,941	26,762	
Pineapple juice and water	28.78	11,804	107,412	4
Soy sauce	0.53	217	1,950	
Salt	0.14	57	499	
Sugar, granulated	4.43	1,817	16,511	
Corn starch	1.09	447	4,128	
Peppers, sweet, fresh	2.20	902	8,210	
Vinegar	2.49	1,021	9,299	5,6,7,8
Totals		41,018	372,122	

TABLE 6 Con't

Procedure:

1. Combine eggs, soy sauce, starch, salt, and garlic powder. Stir until blended. Pour sauce over meat and mix to coat pieces. Let stand for 10 minutes.

2. Cook Pork Dices at 182.2°C in a deep fat fryer until the internal temperature is 71.1°C (approximately 2 minutes).

3. Drain bean sprouts and pineapple saving the liquid to combine with the water requirement.

4. Combine the approximate quantities of juice-water mixture, soy sauce, salt, sugar and cornstarch to make a slurry. Add green peppers and cook mixture for 5 minutes or until starch is thickened.

5. Add cooked meat, vinegar, bean sprouts, and pineapple chunks. Blend and heat mixture to 82.2°C.

6. Adjust volume to 26.5 liters per 100 portions.

7. Weigh 2.3 kg into each half-size steam table pan.

8. Cover, label, and freeze.

Preparation for serving:

Heat in a convection oven, preheated to 162.8° to 176.7°C, to an internal temperature of 73.9°C (approximately 1 to 1.5 hours). Keep pans covered during heating.

TABLE 7. Consumer Panel - Turkey a la King

Sample		Color	Flavor	Texture	Overall Acceptability
01 1/	Average 2/	6.1	7.6	7.2	7.4
	Range	2-8	4-9	2-9	3-9
02 1/	Average 2/	6.1	7.5	7.1	6.9
	Range	2-9	5-9	3-9	4-9

1/ Duplicate samples

2/ N = 28

TABLE 8. Analysis of the Dredging Mix Used for Creole Pork Slices and its Components for Pro-Oxidants

Sample	Copper	Iron	Cobalt	Manganese	Nickel	Ash
	ppm	ppm	ppm	ppm	ppm	%
Dredging mix	1.5	2.8	0.50	4.9	0.37	13.1
Flour	1.5	12.	-	5.4	-	0.5
Salt	0.93	4.7	5.1	0.7	5.6	-
Pepper	11.0	44.0	-	37.	0.74	3.4
Paprika	8.3	200.0	-	16.	0.52	6.6
Thyme	9.	930.0	1.5	70.	4.5	9.3

TABLE 9. Yields Obtained from Boneless Top Rounds

Portion	Weight (kg)	Percent
Boneless Top Round	453.6	100.00
Raw Steaks	148.4	32.7
Lean Trim	166.7	36.7
Waste	132.9	29.3
Not Accounted for	5.4	1.2

TABLE 10. Yields Obtained From Whole Turkeys

Trial 1

Portion	Weight (kg)	Percent
Whole Birds	226.8	100.0
Meat For Rolls	91.6	40.0
Waste*	135.2	60.0

Trial 2

Whole Birds	234.5	100.0
Meat For Rolls	98.3	41.9
Waste*	136.2	58.1

* Carcasses, wings, necks, legs, skin, giblets

TABLE 11. Yields Obtained From Bone-In Loins

Portion	Weight (kg)	Percent
Bone-In Loins*	1,069.4	100.0
Longissimus Dorsi muscle	268.6	25.1
Diced Pork	213.6	20.0
Waste	580.6	54.3
Not Accounted For	6.6	0.6

* Average weight per loin 7.4 kg. Range = 5.8 kg to 8.8 kg.

TABLE 12. Yields Obtained From Whole Chickens

Portions	Weight (kg)	Percent
Whole Chickens	290.3	100.0
Cut Up Parts	223.3	76.9
Giblets	8.9	3.1
Waste	52.0	17.9
Not Accounted For	6.1	2.1

TABLE 13. Results of Microbiological Analyses of Navy Entrees

Product	Aerobic Plate Count (Per g)	Coliform (MPN per g)	E. Coli (MPN per g)	Salmonella (in 25 g)	Sp. Staph (in 5 g)	C. per fringins (per g)
Swiss steak w/brown gravy	43	0	0	Neg	1/	1/
Oven Fried Chicken	332	0	0	1/	1/	1/
Baked Lasagna	11,012	0	0	Neg	Neg	Neg
Sweet and Sour Pork	27	0	0	1/	1/	1/
Creole Pork Slices	146	0	0	1/	1/	1/
Turkey a la King	146	0	0	1/	1/	1/

1/ Not performed

TABLE 14. Mean Ratings[1] of Precooked Frozen Entrees for the Navy[2]

Entree	No. of Panelists	Color	Odor	Flavor	Texture	Appearance
Turkey a la King						
A[3]	16	7.1	7.1	7.3	7.4	6.8
B	16	7.1	6.7	7.4	7.5	6.9
Oven Fried Chicken						
A	13	7.1	7.1	7.0	6.5	6.5
B	13	6.9	7.1	7.0	6.5	6.5
Sweet and Sour Pork						
A	14	7.2	7.3	6.9	7.3	7.1
B	14	7.3	7.4	7.3	7.1	7.5
Swiss Steak w/Brown Gravy						
A	15	7.2	7.1	7.1	6.9	7.1
B	15	7.3	7.3	7.3	7.0	7.0
Lasagna						
A	12	7.2	7.3	7.4	7.5	7.2
B	12	7.4	7.3	7.4	7.5	7.2
Creole Pork Slices						
A	18	7.4	7.2	6.2	7.4	7.3
B	18	7.4	6.7	6.3	7.0	7.2
C	15	7.3	7.0	6.9	7.4	7.1
D	15	7.3	7.0	6.9	7.3	7.1
E	15	7.1	7.1	6.9	6.9	6.8

[1] Ratings based on a 1-9 scale (1 = extremely poor, 9 = excellent).

[2] Technological Panel

[3] A and B are samples from the same production lot.

TABLE 15. Consumer Panel Ratings of Six Precooked Frozen Entrees [2]

Entree	Mean Rating[1]
Turkey a la King	7.67
Oven Fried Chicken	7.08
Sweet and Sour Pork	7.03
Creole Pork Slices	6.64
Swiss Steak w/Brown Gravy	6.72

[1] N = 36

[2] Ratings are based on a 1 to 9 scale (1 = dislike extremely, 9 = like extremely).

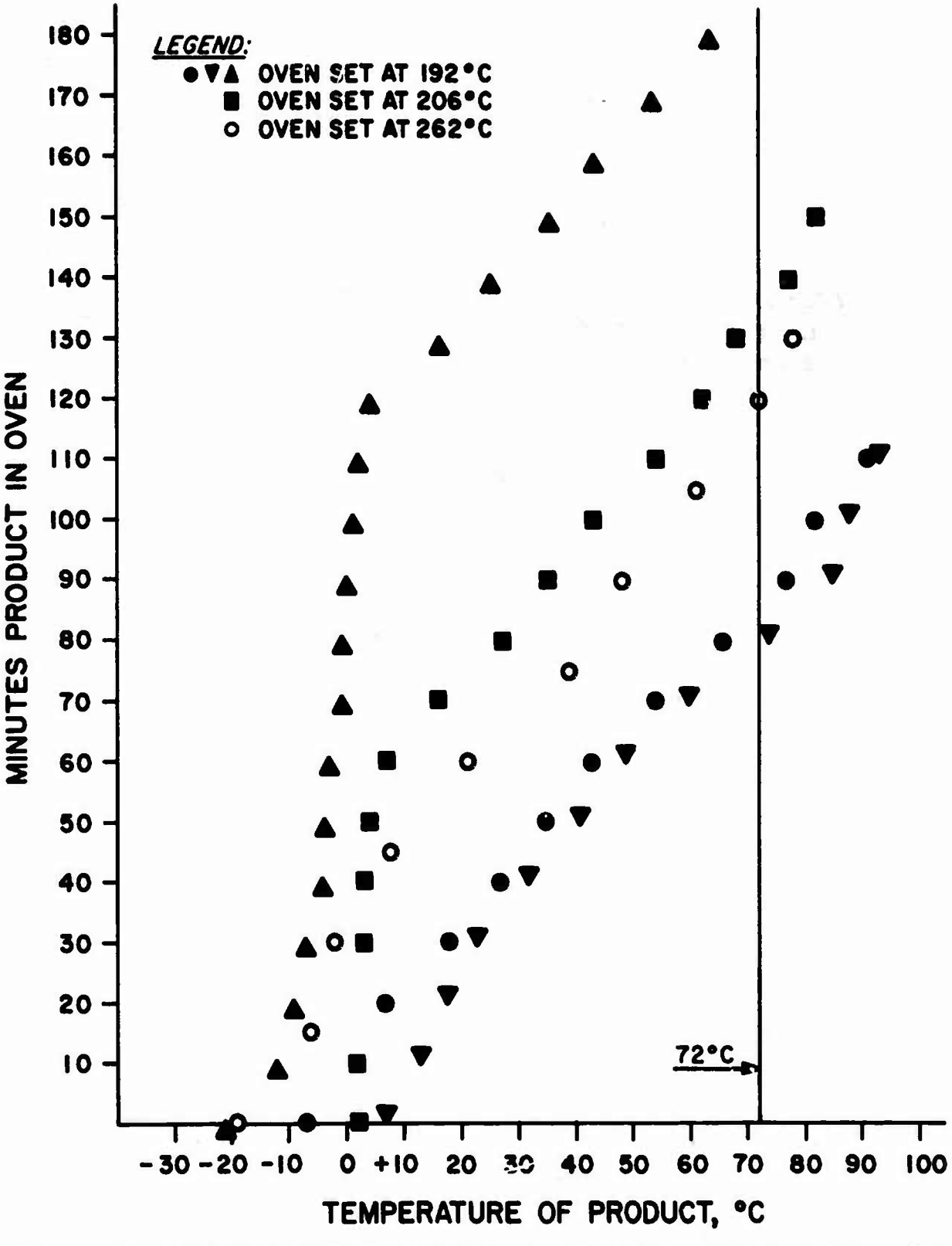

FIGURE I. HEATING CURVES FOR SWISS STEAK WITH BROWN GRAVY

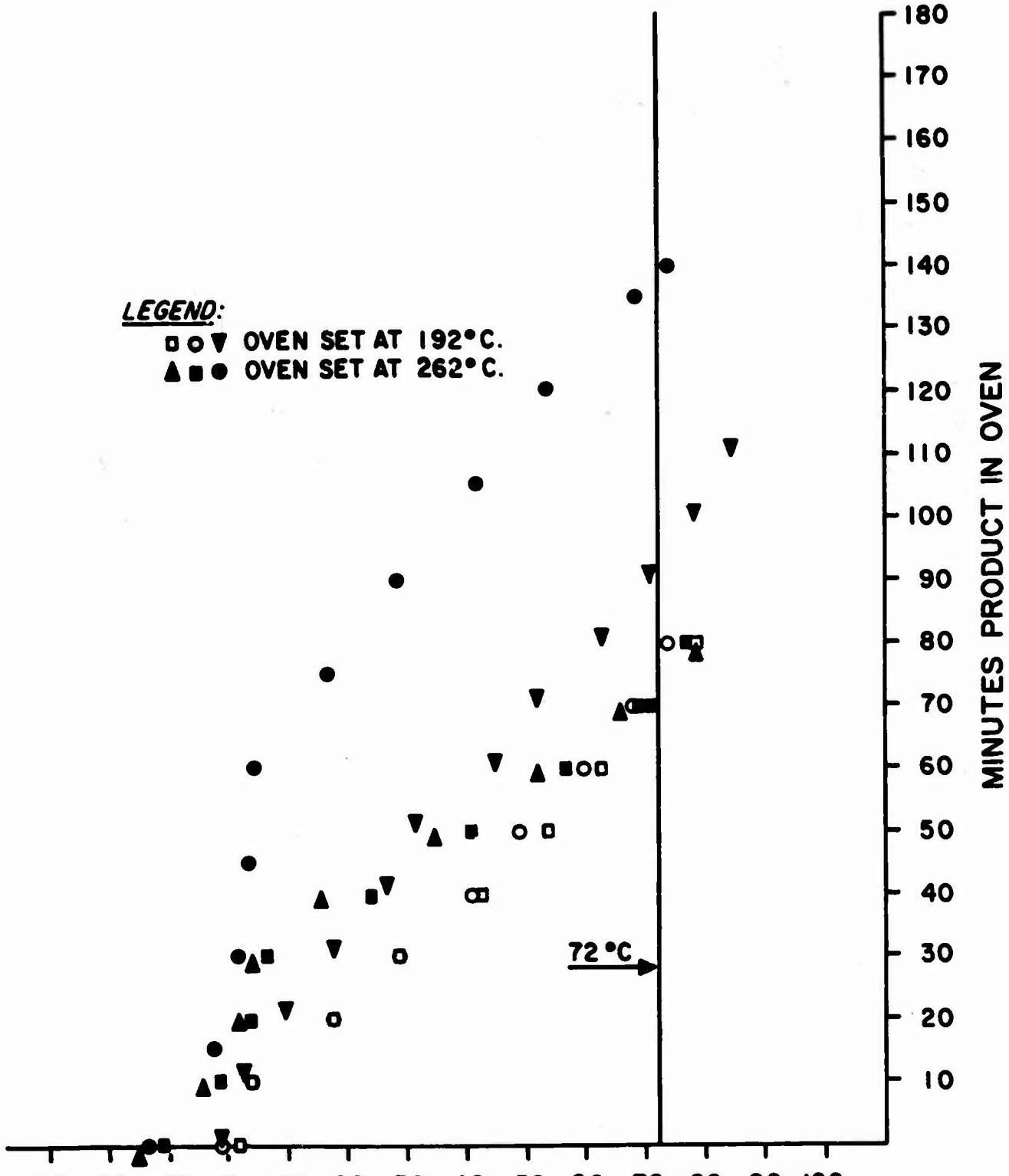

FIGURE 2. HEATING CURVES FOR TURKEY a la KING

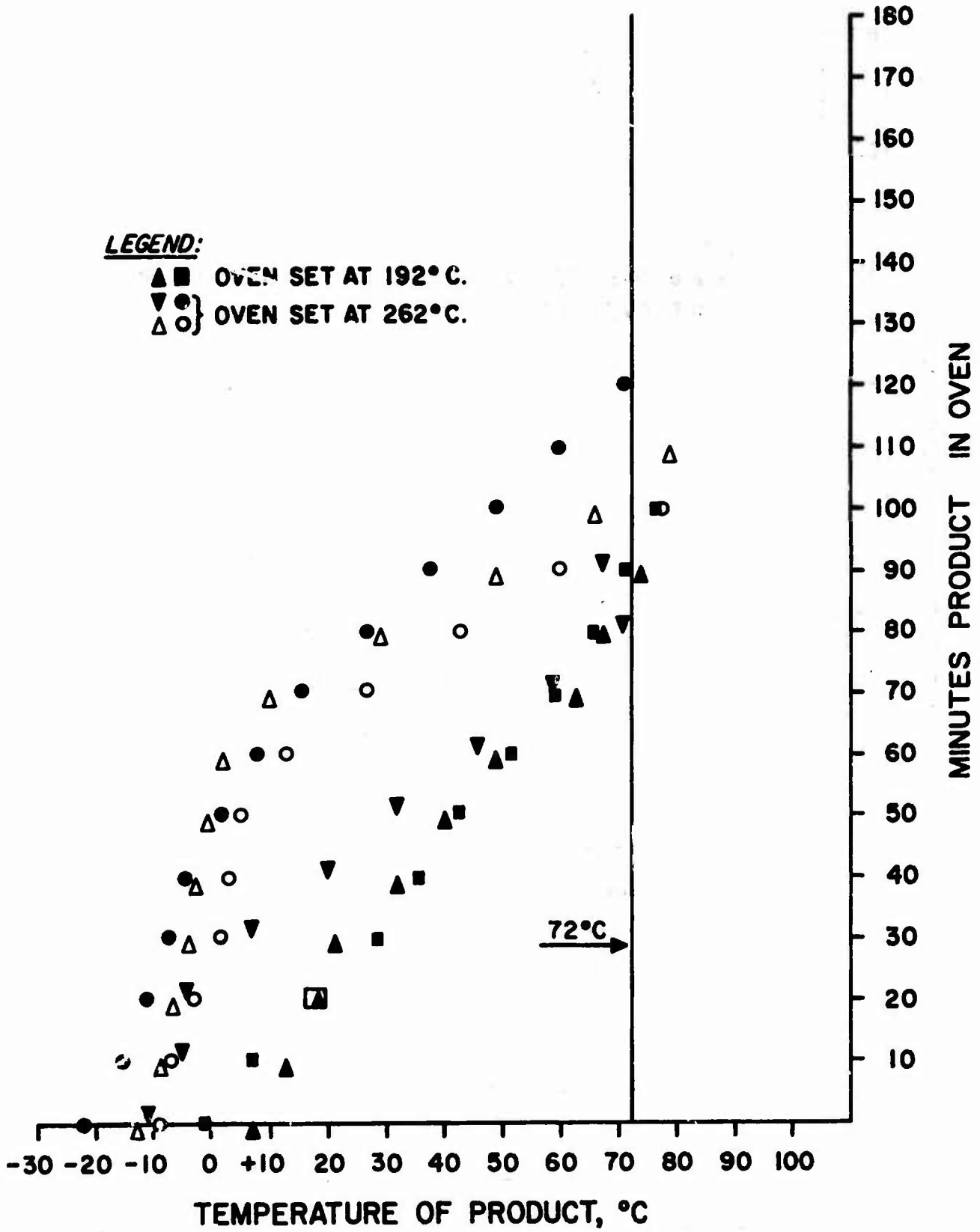

FIGURE 3. HEATING CURVES FOR OVEN-FRIED CHICKEN

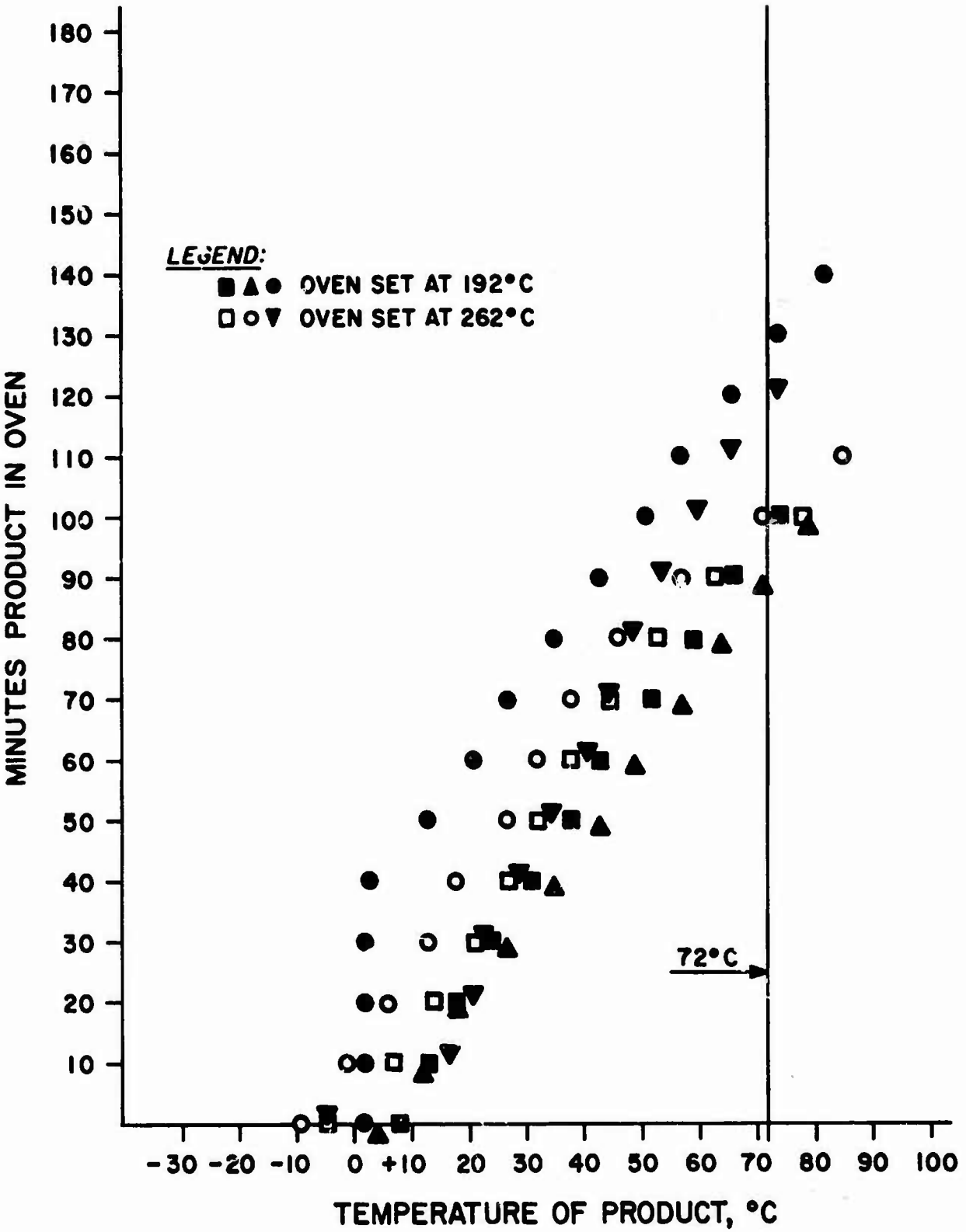

FIGURE 4. HEATING CURVES FOR BAKED LASAGNA

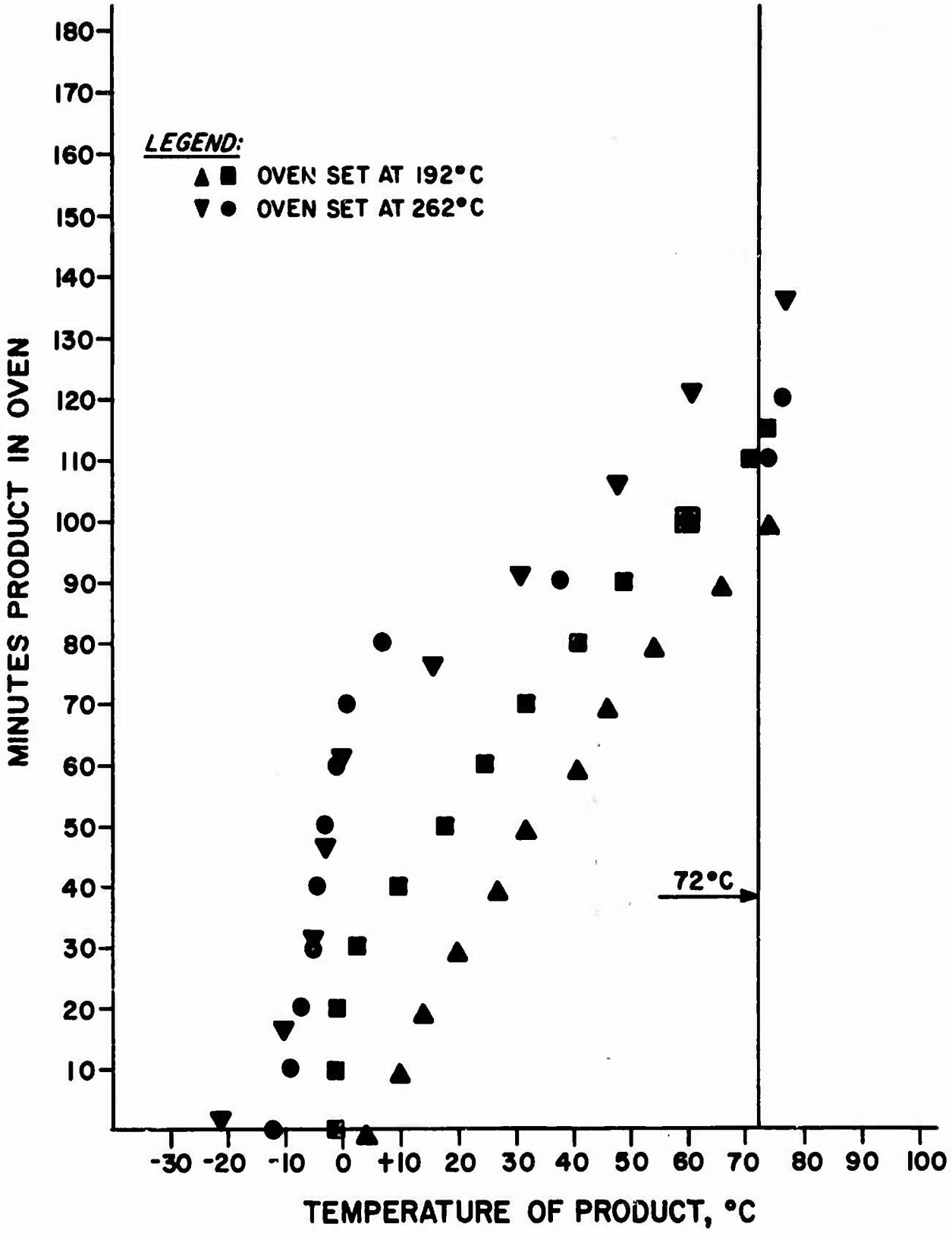

FIGURE 5. HEATING CURVES FOR CREOLE PORK SLICES

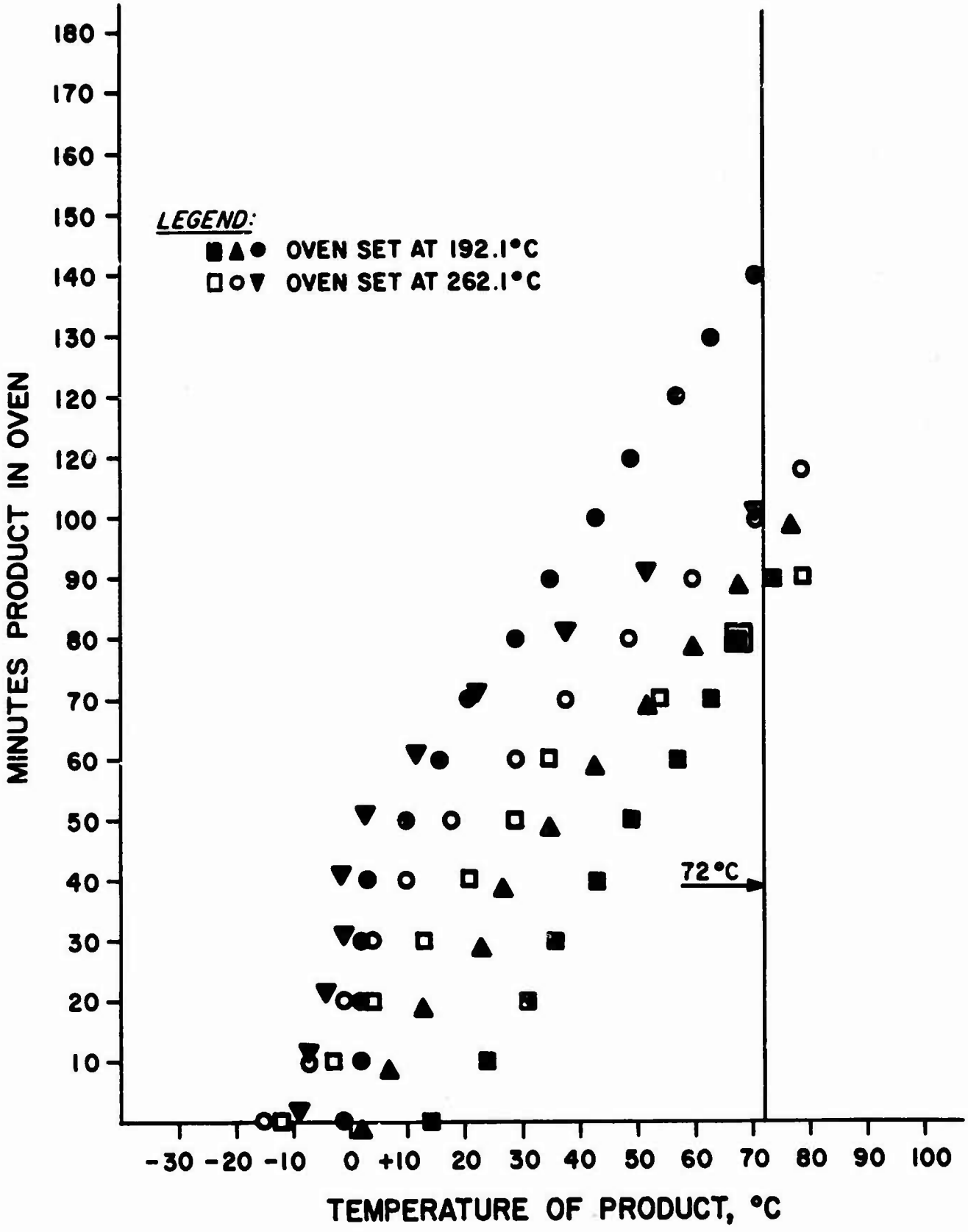

FIGURE 6. HEATING CURVES FOR SWEET AND SOUR PORK

SWISS STEAK WITH BROWN GRAVY
US ARMY NATICK DEVELOPMENT CENTER
NATICK, MA 01760

TURKEY a la KING
US ARMY NATICK DEVELOPMENT CENTER
NATICK, MA 01760

BAKED LASAGNA
US ARMY NATICK DEVELOPMENT CENTER
NATICK, MA 01760

CREOLE PORK SLICES
US ARMY NATICK DEVELOPMENT CENTER
NATICK, MA 01760

SWEET AND SOUR PORK
US ARMY NATICK DEVELOPMENT CENTER
NATICK, MA 01760

OVEN FRIED CHICKEN
US ARMY NATICK DEVELOPMENT CENTER
NATICK, MA 01760

RECOMMENDED PREPARATION:

1. Remove from freezer and place in 40°F box for 24 hours prior to heating.
2. Preheat oven to 375°F.
3. Place product in preheated 375°F oven & heat to an internal temp. of 165°F (approx 1½-2hrs). DO NOT REMOVE COVER.

ALTERNATE PREPARATION:

1. Set oven at 500°F. Preheat.
2. Place frozen product in 500°F oven. Heat until internal temp. is 165°F. (approx 2-2½ hrs). DO NOT REMOVE COVER.

RECOMMENDED PREPARATION:

1. Remove from freezer and place in 40°F box for 24 hours prior to heating.
2. Preheat oven to 375°F.
3. Place product in preheated 375°F oven & heat to an internal temp. of 165°F. (approx 1½-2 hrs). For a crisper product remove cover approx. ½ hour before product is removed from oven.

ALTERNATE PREPARATION:

1. Set oven at 500°F. Preheat.
2. Place frozen product in 500°F oven. Heat until internal temp. is 165°F. (approx 2-2½ hrs). For a crisper product remove cover approx 15 minutes before product is removed from oven.

FIGURE 7. PRODUCT LABELS AND RECOMMENDED METHODS OF PREPARATION

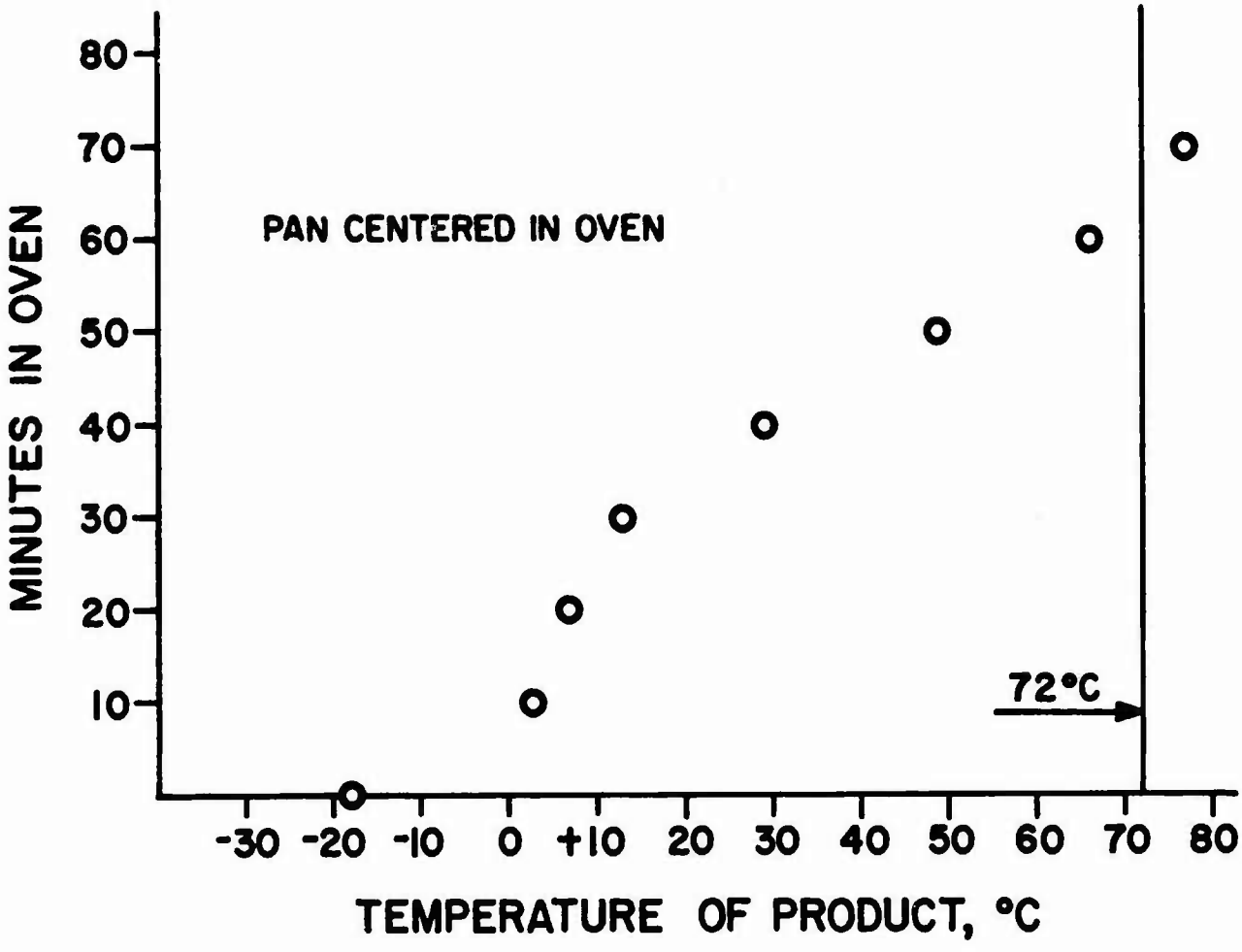

FIGURE 8-A. HEATING CURVE FOR ONE PAN OF TURKEY a la King (Pan Centered in Oven)

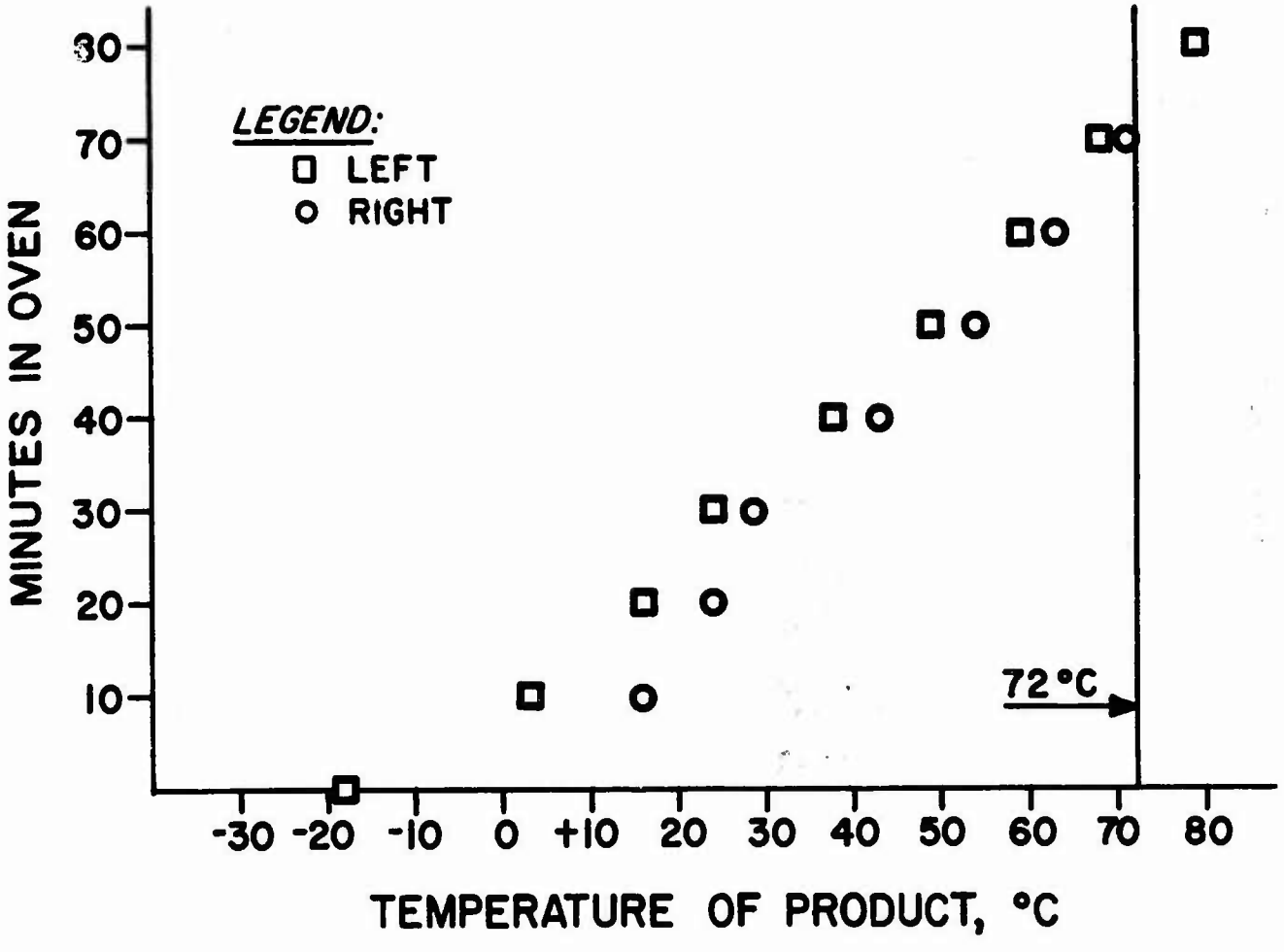

FIGURE 8-B. HEATING CURVES FOR TWO PANS OF TURKEY a la KING (Pans Placed Left and Right of Center of OVEN)

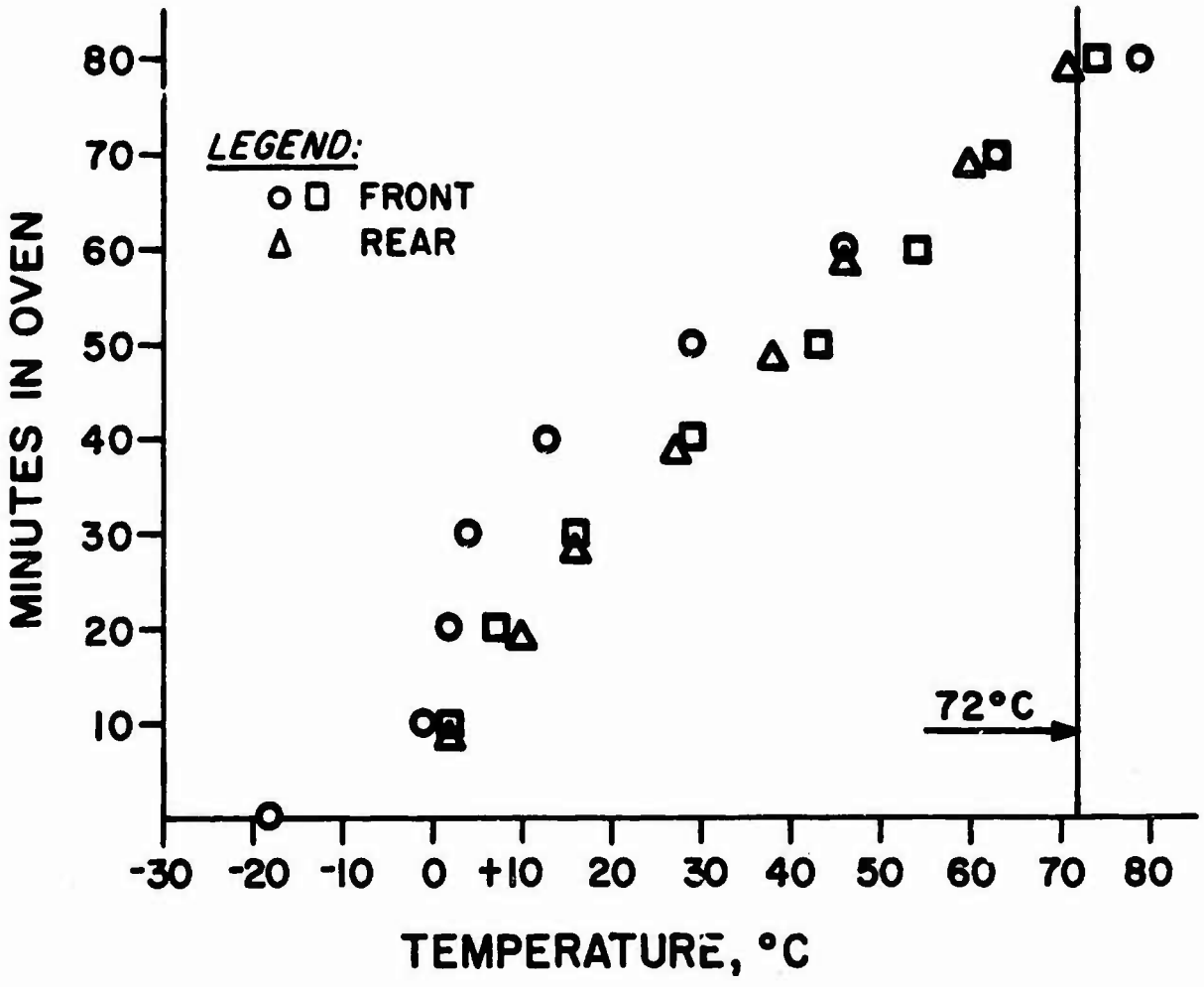

FIGURE 8-C. HEATING CURVES FOR THREE PANS OF TURKEY a la KING (Two Pans Placed Left and Right of Center, Front of Oven; One Pan Placed Center Rear of Oven)

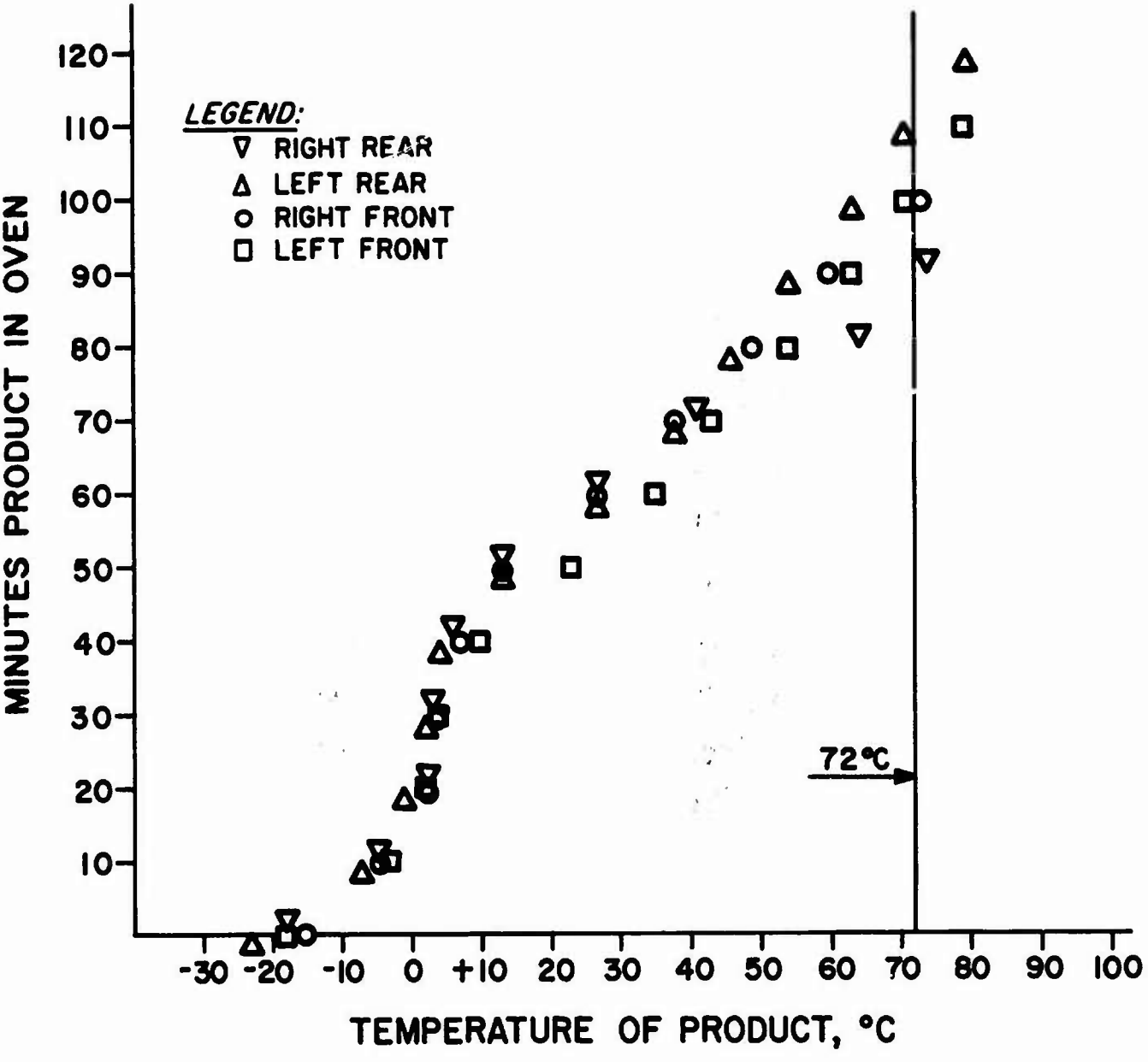

FIGURE 8-D. HEATING CURVES FOR FOUR PANS OF TURKEY a la KING (Pans Placed Right and Left, Front and Rear of Oven)